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MEMOIRS OF NATURAL SCIENCES.

VOL. I. NO. 1.

MEDUSÆ OF THE BAHAMAS

BY

ALFRED GOLDSBOROUGH MAYER.

WITH SEVEN PLATES.

APRIL, 1904.

BIOLOGY

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ALPHABETICAL LIST OF SPECIES.

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INTRODUCTION.

The following observations were made while the writer was in charge of a scientific expedition to the Bahamas under the direction of the Museum of the Brooklyn Institute of Arts and Sciences. The report has received the benefit of valuable suggestions from Professor Charles B. Davenport.

The studies were made in the period extending from June 4-July 27, 1903, and numerous surface hauls were made under most favorable conditions for working.

The medusa-fauna of the Bahamas is poor in comparison with that of the Tortugas, Florida. For example, the writer secured ninety species of Hydromedusæ, Scyphomedusæ, Siphonophoræ and Ctenophoræ at the Tortugas, while only forty-three species were found at the Bahamas.

What is more interesting, the relative abundance of specific forms is quite different in the two regions. Thus the three commonest species at the Tortugas are Pseudoclytia pentata, Halitiara formosa, and Turritopsis nutricula; yet the first was not found at the Bahamas, while the two others were rare. On the other hand one of the commonest medusæ of the Bahama Banks, a new species of Lymnorea, has never been seen at the Tortugas, and species of Netocertoides, Olindias, and Cubaia are abundant on the borders of the Bahama Banks, but very rare at the Tortugas.

Altogether, of 43 Bahama medusæ, 23 are about equally abundant at the Tortugas, and 13 of these are either Trachylina forms or Siphonophoræ, which are widely distributed over the Tropical Atlantic. 16 are more abundant at the Bahamas than at the Tortugas, while 4 are more abundant at the Tortugas. 5 medusæ are known only from the Bahamas, and 2 of these are locally abundant.

These considerable differences in the medusa-fauna of two regions upon the same latitude, and being only about 300 miles apart, are co-ordinated with differences in local conditions. For example, the Tortugas lie to leeward of the Gulf Stream, and the rich pelagic life of the great current is constantly driven upon their shores; while the Bahamas lie to windward of the stream,

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and their local fauna is not reinforced by creatures characteristic of the current. It is interesting to observe, however, that at the Tortugas we find more than a mere concentration of individuals, for a number of characteristic species appear to be confined to this region alone.

Moreover, at the Tortugas we have a small land mass surrounded by pure, deep ocean water, while at the Bahamas we find vast areas of shallow flats, covered mainly with coralline mud. These great banks of the Bahamas are veritable submarine deserts, covered only with a sparse growth of coralline, algæ, and with here and there a cluster of reef-corals and gorgonians.

It is remarkable, also, that the water over these shallow banks is almost as deficient in life as is the desert bottom itself. Almost no Sagittæ, Salpæ or Crustacea being found, and among Medusæ only Olindias, Cubaia, and Lymnorea are abundant.

Indeed, the water over the banks is usually charged with a flocculent mass of silt, which readily adheres to pelagic animals, and appears to be rapidly fatal to them. Only in this manner can we account for the poverty of pelagic life over the Bahama banks, for the deep-water regions of the Bahamas, such as the Tongue of the Ocean or the area to the eastward of Great Abaco Island, are rich in pelagic animals, which appear to be free from silt and in excellent condition. The water from the deep areas must, however, often be driven over the shallow banks and its life destroyed.

The coral reefs of the Bahamas are richer in species than are those of the Tortugas. They are best developed along the windward edges of the banks, the richest single reef being probably that which extends along almost the entire eastern shore of the Andros Islands, about one mile out from the beach. On the other hand fewer species of marine invertebrates and fishes are found among the Bahama reefs than among those of the Tortugas. The actual area occupied by corals is insignificant in comparison with the great extent of barren flats around them.

In general it appears that while the Tortugas fauna is recruited from the pelagic life of the Gulf Stream, and from the drift caused by prevailing winds, the Bahama fauna is depleted by the same winds, and is poor in those creatures which are mainly dependent upon great currents for their distribution.

Morphology, etc. A unique opportunity was afforded for the study of the post-embryonic development of Cubaia, and Olindias, and it appears that

Gonionemus, Cubaia, Vallentinia, Olindioides and Olindias are closely related genera, which may be grouped into one family, the Olindiadæ.* The marginal (velar) tentacles of Cubaia and Olindias are secondary and arise quite late in ontogeny. The distinguishing feature of the Olindiadæ is the development of a pad-like cluster of modified nematocyst cells upon the aboral side, near the distal extremity, of each and all of the primitive tentacles. These pad-like expansions may serve as adhesive disks or organs of temporary attachment.

A study was also made of the phenomenon of asexual budding in medusæ. One of the most interesting examples is afforded by *Eucheilota paradoxica,* which is the only Leptomedusa known that produces an asexual generation of medusæ by a direct process of budding. These daughter medusæ are derived from both entoderm and ectoderm of the gonad of the parent (Fig. 65, Plate VII).

We have, therefore, a graded series of phenomena in the asexual production of medusa buds by hydromedusæ. In forms where the ectoderm and entoderm are both thin-layered and of about equal thickness, such as in the *Sarsiadae* and *E. paradoxica,* both entoderm and ectoderm take an equal share in the formation of the bud. In forms such as Rathkea octopunctata and Lizzia Clapereidei, according to Chun, 1895, a different condition is observed, for the medusa buds are formed entirely within the ectoderm of the parent, although the gastro-vascular cavity of the bud finally acquires a connection with that of the parent; the entoderm of the bud becoming continuous with that of the parent manubrium.

In Bougainvillia niobe from the Bahamas, however, the ectoderm is very thick, and the budding medusæ are developed within it alone; the entoderm remaining inert and passive during the growth of the bud, and no connection ever being established between the gastro-vascular cavities of the bud and the parent. (See Figs. 15-15c, Plate II.) This result may be regarded as due to a gradual process favored by the thickness of the ectoderm, which prevented the deep-lying entoderm from taking an equal share in the formation of the bud, until finally, as in B. niobe, it remains passive throughout the period of the formation of the bud. Medusæ produced from ectoderm alone may, therefore, be phylogenetically homologous with medusæ produced by

* Goto, S. 1903; Mark Anniversary Volume.

the more primitive and universal co-operation of both ectoderm and entoderm.

New Species. Two new species were established, Lymnorea Alexandri, named in honor of the author's constant friend, Alexander Agassiz. It is the most abundant medusa of the Bahama Banks throughout the summer.

The other new form has been named Parvanemus degeneratus, and is the most degenerate free-swimming hydromedusa yet described. It lacks tentacles, sense organs, and peripheral vascular system. It swims, however, with great activity, but is short-lived. In this form nature appears to have performed Loeb's experiment, in which, as is well known, he cut away the rim of the bell, depriving the medusa of tentacles and sense organs. Yet the bell still contracted rhythmically when placed in a solution having the same osmotic pressure as sea water, but having no calcium or potassium ions.

Murbach, 1903; Amer. Journ. Physiology, X, p. 201, has shown, however, that in Gonionemus the marginal otocysts have nothing to do with the maintenance of equilibrium, but that it is probable "that muscular sensation (largely in the velum) is the seat of static function in Gonionemus and in hydromedusæ." It is interesting to observe that the velum of Parvanemus is exceptionally large and provided with powerful muscles. Such "muscular sensation" is not always found in the velum, however, for in Rhacostoma dispar the bell opening is much reduced and the medusa is propelled by the movements of its widely open mouth. Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 61, 1900.

DESCRIPTION OF SPECIES.

For the sake of completeness we present a brief description of all species of Hydromedusæ known from the Bahamas.

The classification is essentially that of Haeckel.

HYDROMEDUSÆ.

Parvanemus degeneratus, gen. et. sp. nov.

Fig. 22, Plate III.

Generic Characters: Parvanemus: Codonidæ without tentacles, radial canals, or circular vessel.

Specific Characters: The bell is thin-walled, about 0.75 mm. high and 0.3 mm. in diameter. The bell-walls are quite rigid and the velum powerful and well developed. There are neither tentacles, radial canals, circular vessel, nor marginal sense organs. The manubrium is spindle shaped and about one-third as long as the bell-height. The fluids within the stomach-cavity are maintained in rapid motion apparently through the action of cilia. Near the aboral end of the bell there is a deep conical cicatrice which evidently marks the place of last connection between the medusa and its hydroid stock. The bell is translucent and milky in color while the manubrium is cream colored. Only five specimens, all males, were found in Nassau Harbor, Bahamas, on the nights of July 18-19. They swam actively in arcs of circles, but all died early in the morning although maintained in large glass dishes filled with pure sea-water. They appeared to be mature, for sperm was discharged constantly from the sides of the manubrium.

This is the only free swimming hydromedusa, yet described, that lacks all traces of tentacles, radial canals, and marginal sense organs. It is even more degenerate than the medusæ of Amalthæa and Pennaria, and may be compared with Eucopella (R. von Lendenfeld, 1883; Zeit. für Wissen. Zoöl., Bd. 38, p. 497), and Agastra (C. Hartlaub, Wissen. Meeresuntersuch. Biologish. Anstalt auf Helgoland, neu folge, Bd. 2, Heft 1, Abt. 2, p. 504, Taf. XXII, Fig. 5, 8-10). In these remarkable medusæ we find neither manubrium nor marginal tentacles. There are, however, eight otocysts, and the radial and circular vessels are well developed.

Syndictyon angulatum, Mayer.

Fig. 6, Plate I.

Mayer, 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 5, Figs. 6-8. Pl. 3.

The bell is 3 mm. high; half egg-shaped, with moderately thick walls, and becomes almost square in cross section when contracted. There are four slender tentacles with fairly thick spindle-shaped ends. These tentacles are each about as long as the bell height, and their distal halves are armed with nematocysts. The basal bulbs of the tentacles are not very large and each one bears an ocellus formed by a cup-like invagination of ectodermal cells. The velum is large, and the radial canals and circular vessel are of fine calibre. The manubrium is spindle-shaped with a narrow tubular œsophagus,

and without an aboral projection. It is about two-thirds as long as the height of the bell-cavity. The entoderm of the tentacle-bulbs and manubrium is robin-egg blue, while the ocelli are deep brown, almost black. All other parts are hyaline. This medusa is abundant in the Tongue of the Ocean in June and July, and was found at Turks Islands in January.

Hybocodon Forbesii, Mayer.

Fig. 13, Plate II.

Mayer, A. G., 1894; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXV, p. 236, Pl. 1, Fig. 1.

Bell higher than a hemisphere. About 2 mm. high. Bell walls thin and transparent. Three rudimentary and one well developed tentacle; the latter 2 mm. long with its distal end swollen, and studded thickly with nematocysts. Velum rudimentary. Entoderm of manubrium bright yellow. That of the distal end of the long tentacle yellow and red. Nassau Harbor, Baha mas. Spring months.

Dissonema turrida, Mayer.

Fig. 10, Plate II.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 44, Pl. 2, Figs. 3, 4.

Bell pyriform, 4 mm. high, with a hollow apical projection. Two large, hollow, tentacles, each about 12 mm. long. Fourteen short slender marginal cirri. Sixteen octodermal ocelli, one on the outer side of the base of each tentacle and cirrus. Manubrium urn-shaped, with four crenulated lips, which project beyond the velar opening. Four broad radial canals with four large sac-like gonads on their proximal halves. Ova large and prominent. Entoderm of manubrium and tentacles delicate green. Gonads and vascular canals delicate pink. Ocelli red. Common throughout summer at Bahamas, and off Florida coast.

Halitiara formosa, Fewkes.

Fig 8, Plate I.

Fewkes, J. W., 1882; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. IX, p. 276, Pl. 4, Fig. 2.

Bell pyriform, 3 mm. high, with solid apical projection. Four long radially situated tentacles, and 24-35 short tentacles with tapering bases. No ocelli. Velum well developed. Four straight narrow radial tubes. Manu-

brium pyriform. Mouth a simple round opening; no prominent lips. Entoderm of manubrium and tentacle bases green in females, light brown in males.

Common at Tortugas; rare in Bahamas. An identical, or very closely allied, form found in the Fiji Islands.

Stomotoca australis, Mayer.

Fig. 9, Plate I.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 32, Pl. 1, Fig. 2.

Bell 2.5 mm. high, with solid conical, apical projection, bell-walls thin. Two large diametrically opposed tentacles at bases of two of the radial canals. Two rudimentary tentacle-bulbs at bases of the other two radial canals. Eight ectodermal ocelli, four on outer sides of the tentacle bulbs and four in intermediate positions 45° from tentacle bulbs. Tentacle bulbs hollow. Velum well developed. Radial canals broad and smooth-edged. Manubrium urn-shaped with four prominent lips. Gonads in complexly folded radially situated regions at upper part of sides of manubrium. Manubrium and tentacle-bulbs greenish yellow, ectodermal core of manubrium and ocelli orange. Common at Tortugas, Florida; not so abundant at the Bahamas.

Tiara superba, Mayer.

Fig. 11, Plate II.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 34. Pl. 16, Fig. 39.

Bell 5 mm. high; pyriform with short apical projection, and thin walls. Four long, hollow, tapering, and twelve rudimentary tentacles; each with bright red ectodermal ocellus on outer side of tentacle-bulbs. Radial and circular vessels broad and smooth-edged. Velum well developed. Manubrium urn-shaped, about two-thirds as long as the height of the bell-cavity, with complexly fluted lips. Four gonads in radially situated folded regions on the proximal parts of the manubrium. Four radial mesenteries bind the manubrium to the walls of the radial canals. Entoderm of manubrium and tentacles rose-pink. Core of the manubrium emerald-green. Gelatinous substance of bell delicate pink. Common at Tortugas, Florida; found occasionally at Bahamas, Andros Island, Tongue of the Ocean, Nassau Harbor in June and July.

Turritopsis nutricula, McCrady.

McCrady, J., 1857; Gymn. Charleston Harbor, p. 25, Pls. IV, V, VIII, Fig. 1.

Modeeria multitentacula, Fewkes, J. W. 1881; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. VIII, p. 149, Pl. III, Figs. 7-9.

Brooks, W. K., 1886; Mem. Boston Soc. Nat. Hist., Vol. III, p. 388, Pl. 37.

Bell 4 mm. high. Pear-shaped, with thin walls. 40-50 marginal tentacles, each with an ocellus on the outer side near the basal bulb. Four narrow radial canals. Manubrium wide, flask-shaped and one-half as long as the depth of bell cavity. Proximal part of manubrium contains large vacuolated cells, through the midst of which the four radial canals extend into the gastric portion of the manubrium. Mouth at end of a short cylindrical tube, and surrounded by four radially-situated nematocyst-bearing knobs. Gonads within the manubrium. Entoderm of manubrium dull yellow streaked with brownish orange. Ocelli of tentacle bulbs brown or orange. The hydroid, discovered by Brooks, is Dendroclava. Medusa common from Cuba to Newport, Rhode Island. Rare at the Bahamas in summer.

Lymnorea Alexandri, sp. nov.

Figs. 1-5a, Plate I.

Named in honor of Alexander Agassiz. Bell 4 mm. high, 3 mm. broad, with vertical sides, flat top and thin walls. Thirty-two slender tentacles with tightly coiled ends and large basal bulbs. A black ectodermal ocellus lies upon the outer side of each tentacle-bulb. The velum is well-developed. The four radial canals are straight and slender but slightly swollen in the mid-regions of their lengths, where their inner sides are lined with gland-cells. (Fig. 5^{a}, Plate I.)

The manubrium is flask-shaped and about one-half as long as the depth of the bell-cavity. The distal part of the manubrium adjacent to the points of entrance of the four radial canals is composed of highly vacuolated cells. The mid region of the manubrium is cruciform in cross section and the mature genital products are found in the ectoderm. The mouth is at the extremity of a short neck, and is surrounded by four oral tentacles, each of which branches dichotomously three times, and terminates in eight nematocyst-bearing knobs, making in all thirty-two of these knobs surrounding the mouth. The entoderm of the manubrium and tentacle-bulbs is dull, flesh-colored pink. In the youngest medusa seen the bell was 0.6 mm. in diameter, and had only four oral tentacle knobs, four marginal tentacles and four rudi-

mentary tentacle-bulbs. This is one of the most abundant medusæ at the Bahamas in summer.

Bougainvillia Niobe, Mayer.

Figs. 14-15c, Plate II.

Mayer, A. G., 1894; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXV, p. 236, Pl. I, Fig. 2; Ibid. Vol. XXXVII, p. 42.

Adult Medusa, Fig. 14. Bell 6.75 mm. high and 4.8 mm. in diameter, with vertical sides and thick gelatinous walls. Four radially situated clusters of marginal tentacles, each composed of about eight tentacles about as long as the bell height. On the lower side of each tentacle near the bulbous base there is a dark-colored ocellus. Four straight, narrow, radial canals. Manubrium wide, flask-shaped, and cruciform in cross section. About one-half as long as the height of the bell-cavity. Four radially situated clusters of oral tentacles, each of which branches dichotomously four times. These are very flexible, and their distal ends are knobbed.

Medusa buds arise from the eight adradii of the manubrium (Fig. 15); the youngest buds being immediately under and on both sides of the point of entrance of each radial canal, while older ones are found farther down the sides of the manubrium. The youngest buds (Fig. 15ª, Plate II) were small ovoid vesicles contained entirely in the ectoderm. The limiting membrane, *sl*, between the entoderm and ectoderm of the manubrium, in the neighborhood of these buds, was entire, and I could find no evidence of cells passing through it. Indeed, throughout the future development of the buds the entoderm remained inert and its limiting membrane unbroken. The wall of the vesicle consisted of two layers of cells; an outer epithelium of ectodermal cells, *e c t. b.*, destined to give rise to the ectoderm of the bud, and an inner layer of somewhat larger cells destined to give rise to the entoderm of the budding medusa, *e n t. b.*, Fig 15ª. These latter cells, it will be observed, are entirely encased by the ectoderm of the manubrium. They may, however, have been derived at an earlier stage from the entoderm, and have migrated into the ectoderm. Careful search has, however, failed to reveal evidence of any such migration, and in default of evidence to the contrary, we assume that these cells *may* be ectodermal in origin, although destined to produce the entoderm of the bud.

The central cavity of the vesicle is partially filled with a loose mass of

nuclei and cell material showing little or no trace of cell boundaries (c, Fig. 15[a]). These are present at all stages of the developing bud, partially filling the gastro-vascular cavity, but they appear to degenerate in later stages, and it seems possible that they serve to nourish the bud in its growth. This supposition appears the more probable from the fact that the gastro-vascular cavity of the bud is never in connection with that of the parent medusa (see Fig. 15[c]). Fig. 15[b] shows a young stage of the bud wherein the entoderm has become a cup-shaped vesicle, and the ectoderm is hollowing out to form the bell-cavity. Fig. 15[c] is a late stage showing that the limiting membrane, *sl.* of the manubrium of the parent medusa remains unbroken, and that the entoderm of the parent medusa, *ent.*, never comes into contact with that of the bud, *e n t. b.*

Netocertoides brachiatum, Mayer.

Fig. 7, Plate I.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 45, Figs. 43-44; Pl. 18.

Bell 3.5 mm. high, mitre-shaped, walls quite thin. Sixteen hollow tapering tentacles; one at the base of each of the sixteen radial canals. 16-25 small tentacles, one or two between each pair of the long ones. Longest tentacles are about one-quarter as long as the bell-height and their distal ends are tightly coiled. The short tentacles are hardly more than cirri. No marginal sense organs. Velum well developed. Eight main radial canals arise from the manubrium, but each bifurcates, giving sixteen radial canals, which extend straight toward the circular vessel. The eight proximal roots of the radial canals are bound to the manubrium by simple mesenteries. The manubrium is broad and disk-like and the mouth is at the extremity of a short neck, and is surrounded by four simple lips. Gonads within the eight main radial canals. The entoderm of the tentacles, radial canals and manubrium is rosin-colored. Quite common at the Bahamas, but rare at the Tortugas, Florida. Seen only in summer.

Tetracannota collapsa, Mayer.

Fig. 32, Plate IV.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 46, Figs. 14-16, Plates 7, 8.

Fewkes, J. W., 1883; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XI, No. 3, Figs. 7, 7[a].

Mature medusa: Bell higher than a hemisphere and 7 mm. in diameter,

sixteen well developed, tightly coiled tentacles, and about 112 small marginal cirri. A dark brown entodermal ocellus is found near the base of each cirrus. There are sixteen radial canals, which arise from the gastric portion of the manubrium in four radially situated groups of four canals each. The manubrium has a wide basal peduncle which fills the major portion of the bell-cavity. Eight prominent recurved lips. The sixteen gonads are on the proximal parts of the sixteen radial canals close to the manubrium. Entoderm of manubrium dull yellow or green, and of tentacle-bulbs dull brownish yellow. Common at Bahamas and Tortugas, Florida, in summer.

Willia ornata, McCrady.

Fig. 12, Plate II.

McCrady, J., 1857; Gymn. Charleston Harbor, p. 47, Pl. 9. Figs. 9-11.
Agassiz, A., 1865; North Amer. Acal., p. 171. Figs. 274a-279.
Brooks, W. K., 1881; Studies Johns Hopkins University Marine Lab., Vol. II., p. 144.
Willia gemmifera, Fewkes, J. W., 1882; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. IX., p. 300, Fig. 24, Pl. I.

Bell hemispherical, 5 mm. in diameter, with a small apical projection. There are sixteen marginal tentacles with well developed bulbs, each of which arises at the point of juncture between the radial vessels and the circular canal. Four radial canals arise from the manubrium, and each of these gives rise to three side branches, so that sixteen canals reach the circular vessel. Sixteen very slender tubes arise from the circular canal and each ends blindly within the gelatinous substance of the bell. Several distinct clusters of nematocysts are usually found on the ex-umbrella surface immediately over each of these tubes, although in some individuals there is but a single cluster over each tube. The manubrium is wide and flask-shaped, and provided with four prominent recurved lips. The gonads are situated at the four radial corners of the manubrium. The entoderm of the manubrium is sage-green-yellow, while the tentacle-bulbs are brownish. In every respect this medusa resembles the Willia ornata of Charleston and Newport harbors. It seems probable that Willia gemmifera is only a southern variety of this medusa which produces medusæ asexually through budding at the points of juncture of the four radial canals with the manubrium. The only difference of specific value between gemmifera and ornata is that in the former there is but *one* cluster of nematocysts over the blindly ending diverticulæ of the circular vessel, whereas in W. ornata there may be one or *several* such clusters

over each diverticulum. The manubrium in W. gemmifera is long and slender while that of W. ornata is short and broad; but these differences may be all due to the absence of sperm or ova in W. gemmifera. W. ornata is abundant at the Bahamas and is occasionally found at the Tortugas. W. gemmifera is found at the Tortugas and off the Carolina coast.

Laodicea ulothrix, Haeckel.

Fig. 30, Plate IV.

Laodice ulothrix, Haeckel, 1879; Das System der Medusen, p. 133, Taf. VIII., Fig. 5-7.

Bell about 20 mm. in diameter, and a little flatter than a hemisphere. 70-100 stiff tentacles about one-third as long as the bell-diameter. These have their distal ends coiled tightly. The tentacle-bulbs are large and hollow, and there is a dark brown ectodermal ocellus upon the inner (sub-umbrella) side of each bulb. Some of the tentacle-bulbs show spur-like projections upon the exumbrella side. Small sensory clubs and coiled cirri are scattered between the tentacles. The cirri are usually somewhat less numerous than the tentacles, while the clubs are about equal in number to the tentacles. There are no otoliths. There are four straight, narrow radial tubes. The manubrium is short and cruciform in cross section, with four recurved lips. The gonads are found on the four radial canals adjacent to the manubrium. The entoderm of the manubrium, gonads, and tentacle-bulbs is variable in color, being dull pink, brownish or greenish white. This medusa is abundant at the Canary Islands, Tortugas, and Bahamas.

Tiaropsis punctata, Mayer.

Fig. 21, Plate III.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII., p. 49, Figs. 60-63, Pl. 22.

Tiaropsis diademata, Fewkes, J. W., 1882; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. IX., p. 277, Pl. VII., Figs. 13-14.

Bell about 4 mm. in diameter, bluntly cone-shaped or hemispherical, Four radially situated tentacles with well developed basal-bulbs and coiled distal ends. Four interradial tentacle-bulbs, and eight sense organs, two in each quadrant. Each sense organ consists of a pocket-like fold of the velum, containing 8-13 otoliths and immediately above them a large pigmented eye spot. Four straight, narrow radial canals upon the upper portion of which the gonads are situated. The manubrium is wide and flask-like, with four

recurved lips. The entoderm of the manubrium, gonads, and tentacle-bulbs is reddish brown or dull yellow. Found at the Bahamas and Tortugas in summer. Not very common.

Oceania McCradyi, Brooks.

Figs. 23-24, Plate III.

Epenthesis McCradyi, Brooks, W. K., 1888; Studies Johns Hopkins Univ. Biol. Lab., Vol. IV., p. 147-162, Pls. 13-15.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII., p. 50, Figs. 56-59, Pl. 21.

Adult Medusa: Bell flat; 12 mm. in diameter. 20-25 slender tentacles, with well developed basal-bulbs. 20-25 simple otocysts, each containing a single otolith, alternating with the tentacles in position. Velum well developed. Manubrium quadrate, urn-shaped, and with four recurved lips. Four straight, slender, radial canals. Four gonads, each at the centre of a radial canal. Elongate, slightly curved, club-shaped hydroid blastostyles are borne on the gonads of the male medusæ. These blastostyles give rise to medusæ by budding. When set free the medusæ are about 0.7 mm. in diameter and have eight tentacles alternating with eight otocysts. The ectoderm of the blastostyle is directly continuous with that of the gonad from which it arises, but its entoderm is not in direct connection with that of the parent medusa. Supporting lamella of the bell pink, entoderm of gonads, manubrium and blastostyles dull green sprinkled with gray pigment granules. Abundant in the Bahamas in summer; not found in winter. Rare at the Tortugas, Florida.

It is interesting to observe that Hartlaub, 1897; Hydromedusen Helgolands, has demonstrated that in Bougainvillia supreciliaris, and Margelopsis Haeckelii, some of the ova develop into planulæ within the ectoderm of the parent medusa.

Epenthesis folleata, McCrady.

Figs. 16, 16a, Plate III.

McCrady, J., 1857; Gymn. Charleston Harbor, p. 98.

Brooks, W. K., 1882; Studies Johns Hopkins Biol. Lab., Vol. II., p. 138.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII., p. 52, Fig. 139, Pl. 41.

Bell flatter than a hemisphere, and about 5 mm. in diameter. Sixteen marginal tentacles, alternating with sixteen otocysts, each containing a single otolith. Four straight radial canals upon which, near to the circular vessel, are the four gonads. Manubrium small and urn-shaped, with four

slightly recurved lips. Entoderm of manubrium, gonads and tentacle-bulbs usually green. Common off Bahamas, Florida, and Carolina coasts in winter and spring. Rare after mid summer.

Obelia sp.

Figs. 19-20, Plate III.

Agassiz, A., 1888; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. IX., p. 149.
Mayer, A. G., 1900; Ibid., Vol. XXXVII., p. 52.

Bell flat and disk-like. About 3 mm. in diameter. About 100 stiff tentacles, each one-quarter as long as the bell diameter. Eight otocysts at the bases of eight of the tentacles, two in each quadrant. Four gonads large and distended. When mature they lie near the middle of the radial canals. Entoderm of manubrium and tentacle-bulbs milky in color. Bell transparent. Common at the Bahamas, rare at Tortugas, Florida. Hydroid unknown.

Eucheilota paradoxica, Mayer.

Figs. 17-18, Plate III; Fig. 65, Plate VII.

Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII., p. 56, Fig. 134-136, Pl. 40.

Mature Medusa: Bell about 4 mm. in diameter, and more than a hemisphere, with a slight apical projection. Four large radially situated tentacles each flanked by two short coiled cirri. The basal-bulbs of these tentacles are large and hollow. There are also four interradial rudimentary tentacle-bulbs, each flanked by a pair of cirri. Eight otocysts, two in each quadrant, each otocyst bearing a single otolith. Four straight slender radial canals in the middle of each of which the gonads are situated. Manubrium small and flask-shaped, with four simple lips. Color of entoderm of manubrium, gonads and tentacle-bulbs dull milky green. In the young medusa, the gonads are adjacent to the manubrium, but they finally migrate down the radial canals so as to come to lie upon the middle of each canal. Medusa buds arise from these gonads. When set free each medusa has four well developed radially situated tentacles as in the adult, but the interradial tentacle-bulbs lack lateral cirri. A number of the budding medusæ were killed in Flemming's fluid and sectioned, and it appears that both entoderm and ectoderm of the gonad of the parent take part in the formation of the bud which is thus formed, as are the medusa buds of the Sarsiadæ or those of the hydroids (Fig.

65, Plate VII). It is interesting to see that even before it is set free the gonads of the budding medusa are well developed (b., Fig. 65).

Phortis pyramidalis.

Fig. 25, Plate III.

Eutima pyramidalis, Agassiz, L., 1862; Cont. Nat. Hist. U. S., Vol. IV., p. 363.
Agassiz, A., 1865; North Amer. Acal., p. 118.
Haeckel, E., 1879; Das Syst. der Medusen, p. 191.

Phortis pyramidalis, Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII., p. 59, Figs. 21, 21a, Plate 10.

Mature Medusa: Bell about 35 mm. in diameter. Slightly flatter than a hemisphere. The gelatinous substance is thick and rigid, and the manubrium is situated at the extremity of a wide, conical peduncle, which fills the greater portion of the bell-cavity. About 100 short tentacles alternating with 100 otocysts each containing a single otolith. No lateral cirri. Four narrow straight radial canals. Four gonads upon the radial canals near the circular vessel. Manubrium small and urn-shaped with four prominent recurved lips. Manubrium, gonads, and tentacle-bulbs delicate turquoise, other parts transparent. Common at Bahamas and Tortugas. Brilliantly phosphorescent at night, giving an intense blue-green light.

Zygodactyla cyanea, L. Agassiz.

Figs. 26, 27, Plate III.

Agassiz, L., 1862; Cont. Nat. Hist. U. S., Vol. IV., p. 361.
Agassiz, A., 1865; North Amer. Acal., p. 107, Fig. 159.
Mayer, A. G., 1900; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XXXVII, p. 60, Figs. 23, 23a, Pl. 11, Figs. 33, 34, Pl. 15.

Bell about 45 mm. in diameter, flatter than a hemisphere. Gelatinous substance of the central part of the bell thick with a well developed peduncle, which projects downward into the cavity of the stomach. Peripheral zone of the bell thin and flexible. About 100 long tentacles and 100 simple straight radial canals upon which the linear gonads are situated. Each tentacle-bulb hollow and conical, and provided with a conical excretion papilla which projects outward from the exumbrella side of the bell. In addition to the well developed tentacles there are about 300 small rudimentary tentacle-bulbs, each provided with an excretion papilla, and also about 300 otocysts each containing two otoliths. The manubrium is wide and shallow and does not project beyond the velar opening. There are as many

lips as there are radial canals. The radial canals enter the stomach at the highest point, and do not extend down the peduncle. The entoderm is delicate blue-green. Common off the Florida coast and Bahamas.

Cladonema Perkinsii.

Fig. 35, Plate IV.

Cladonema, sp., Perkins, H. F., 1902; Johns Hopkins Univ. Circ., Vol. XXI., No. 155, p. 25. Figs. in text.

Bell half egg-shape; less than 2 mm. in diameter. Bell-walls thin and uniform. Eight large unbranched tentacles, the distal ends of which bend outward. The inner and lateral sides of each of these tentacles bear 3-10 flexible cirri which are besprinkled with wart-like clusters of nematocysts and terminate in a knob. There is a large ectodermal, cup-like ocellus, with a lens upon the outer side of each tentacle bulb. Velum large, and with circular striations. Manubrium large and spindle-shaped with about six rounded protruding pouches at its widest part. Mouth surrounded by five oral tentacles, each ending in a ball of nematocysts. The manubrium is thus octameral at top, hexameral in the middle, and a five-pointed star at the mouth. Genital products develop in the ectoderm of a large part of the manubrium. Ocelli black, all other parts colorless. Found by Dr. H. F. Perkins swimming on the surface at night in July, 1902, in Nassau Harbor, Bahamas.

Description and figure taken by permission from Dr. Perkins.

THE OLINDIADÆ.*

The most characteristic medusæ of the shallow water of the Bahama banks are species of Cubaia (Gonionemoides) and Olindias. These together with Olindioides, Gonionemus, Vallentinia, and possibly Limnocnida and Limnocodium may be grouped under a single family.

Olindiadæ: With a pad-like cluster of modified nematocyst cells upon the aboral side, near the distal extremity, of some or all of the tentacles. With four or six radial canals, and with or without blindly-ending centripetal canals. With gonads upon the radialcanals.

*See Goto, S., 1903; Mark Anniversary Volume, p. 3-22, Pls. I.-III. Also, Perkins, H. F., 1903; Proc. Acad. Nat. Sci. Philadelphia, p. 750-790, 5 Pls.

GENERA AND SPECIES.

Gonionemus.

Gonionemus, Agassiz, A., 1862.
Gonynema, Haeckel, 1879.
Gonionema Perkins, 1902.

Generic characters: With an adhesive disk near the distal extremity of each and all of the tentacles. Tentacles all similar each to each, and projecting in a zone from the sides of the bell, above the margin, their entodermal cores traversing the gelatinous substance of the bell. Four gonads, ribbon-like and deflected alternately to one side and the other of the radial canals. No blindly-ending centripetal canals. Numerous otocysts upon the bell-margin.

Species:

G. vertens, Gulf of Georgia, State of Washington; Alaska.
A. Agassiz, 1865; North Amer. Acal., p. 128; Murbach and Shearer, Proc. Zoöl. Soc., London, 1903, Vol. II., p. 183.

G. Murbachii, Wood's Holl, Massachusetts.
Murbach, 1895; Journ. Morphol., XI., 2.
Perkins, 1903; Proc. Acad. Nat. Sci., Philadelphia, 1902, p. 750-790, 5 Plates.

G. suvaensis, Suva Harbor, Fiji Islands.
Agassiz and Mayer, 1899; Bull Mus. Com. Zoöl., XXXII., 9.

G. Agassizii, Unalaska, Aleutian Islands.
Murbach, 1902; Annal. Mag. Nat. Hist., Ser. 7, IX., p. 73.
Murbach and Shearer, 1903; Proc. Zoöl. Soc., London, p. 185, Pls. XXI., XXII.

G. depressum, Yokohama, Japan.
Goto, S., 1903; Mark Anniversary Volume, p. 12, Pls. II., III.

Cubaia.

Cubaia, Mayer, 1894.
Gonionemoides, Mayer, 1900.

Generic characters: Tentacles are of two distinct kinds. Those of one set are provided with adhesive pads, as in Gonionemus, and project from a zone slightly above the bell-margin, their entodermal axes traversing the gelatinous substance of the bell. The other tentacles arise from the bell-margin, and are provided with terminal clusters of nematocysts but not with adhesive pads. The gonads are papilliform. There are no centripetal canals. There are numerous otocysts upon the bell-margin projecting freely into the water.

Species:

C. aphrodite, West Indies, Bahamas, Tortugas.
Mayer, 1894; Bull. Mus. Comp. Zoöl. XXV., p. 237.
Ibid (Gonionemus aphrodite) XXXVII., p. 62.

C. geophila, (Gonionemoides geophila); Bahamas, Florida.
Mayer, 1900; Bull. Mus. Comp. Zoöl. XXXVII., p. 62. Immature medusa.
"Ireniopsis primordialis," Bull. Mus. Comp. Zoöl., 1894; XXV., p. 238.

VALLENTINIA.

Vallentinia, Browne, 1902.

Generic characters: Similar to Cubaia, excepting that the gonads are sac-like, and the otocysts are "enclosed inside the margin of the umbrella."*

Species:

V. falklandica; Falkland Islands.
Browne, 1902; Annal. Mag. Nat. Hist., Ser. 7, IX., p. 284.

Olindias.

Olindias, F. Müller, 1861.
Halicalyx, Fewkes, 1882.
Halicalyx, Mayer, 1900.
Olindias, Goto, 1903.

Generic characters: The tentacles are of two sorts. Those of one sort arise from the bell-margin, while those of the other set project from the sides of the bell, in a zone above the margin, as in Gonionemus and Cubaia. There are pad-like clusters of nematocysts on the aboral side near the distal extremity of the tentacles. These may or may not function as adhesive disks. The gonads are papilliform. There are four complete radial canals, and a number of blindly ending centripetal canals. The otocysts are at the sides of the tentacle-bases, above the velum, and project inward toward the bell cavity.

Species:

Olindias, Mulleri; Mediterranean.
Haeckel, E., 1879; Syst. der Medusen, p. 253, T. af. XV., Fig. 10.
Goto, S., 1903; Mark Anniversary Volume, p. 14.

OLINDIOIDES.

Olindioides, Goto, 1903.

Generic characters: Two sets of tentacles. Those of one set arise from the bell-margin, are highly contractile and armed with partial rings of nematocysts. The tentacles of the other set project at various levels from the sides of the bell, their entodermal cores traversing the gelatinous substance. They each bear an adhesive patch of ectodermal cells at or near their extremities; six gonads, one on each radial canal, ribbon-like, and folded; six complete radial canals, and numerous blindly-ending centripetal vessels. Otocysts as in Olindias.

Species:

Olindioides formosa, Misaki, Japan.
Goto, S., 1903; Mark Anniversary Volume, p. 1-22, Pls. I., II.

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*Description meagre. Figures lacking.

The species of Olindiadæ are few in number but are widely scattered. Nevertheless the geographical range of each species is remarkably restricted. It seems probable, therefore, that they belong to an ancient race that has suffered extinction in the greater part of the world.

They exhibit relationships both to the Eucopidæ and Trachomedusæ,* and are distinguished by the fact that their primitive tentacles bear adhesive disks upon their aboral sides near their distal extremities. These primitive tentacles are retained throughout life, and project from the sides of the bell above the margin. The marginal, or "velar," tentacles are phylogenetically recent, and arise quite late in ontogeny.

A study of the ontogeny of Cubaia and Olindias shows that the adhesive disks of their primitive tentacles are formed from modified nematocyst cells which gradually group themselves so as to form a cup-shaped or pad-like cluster.

ANALYSIS OF THE GENERA OF OLINDIADÆ.

GENERA.	TENTACLES.	GONADS.	CANALS.
Gonionemus...	Of one sort only. All have adhesive disks and project from sides of bell.	Ribbon-like, folded sinuously.	4 radial canals only.
Cubaia.....	Two sets of tentacles, one set projecting from sides of bell; other set arising lower down from bell margin.	Papilliform.....	" " "
Vallentinia.....	" "	Sac-like.....	" " "
Olindias.....	" "	Papilliform.....	4 radial and numerous centripetal canals.
Olindioides.....	" "	6, ribbon-like...	6 radial and numerous centripetal canals.

Cubaia aphrodite, Mayer.

Figs. 43-49, Plate V.

Mature Medusa: Figs. 45-49. Bell slightly flatter than a hemisphere and about 12 mm. in diameter. About eighty tentacles. About twenty of these project from the sides of the bell in a zone above the bell-margin, their entodermal axes extending through the gelatinous substance of the bell. These tentacles are ringed at regular intervals with about eight nodular swellings containing nematocysts. On the aboral side near the distal end of each

* See Goto, 1903; Mark Anniversary Volume; also Perkins, 1903; Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 750-790.

tentacle, there is a large adhesive disk, while beyond this the extremity of the tentacle bends at a right angle to the main shaft. This extreme tip of the tentacle bears a large grape-like cluster of nematocyst cells (see Fig. 49).

The remaining 50-60 tentacles arise from the bell-margin at a lower level than the zone of origin of the adhesive tentacles. They are somewhat flexible, and project downward rather than outward. They have no adhesive disks, but are provided with 25-30 rings of nematocysts and terminate in a knob-like cluster of nettling cells (see Fig. 48).

There are about thirty-five otocysts each containing a single spherical otolith (Fig. 47). These otocysts all arise from the bell-margin close to the bases of the marginal (non-adhesive) tentacles. They project downward freely into the water. The velum is well developed. The circular vessel is simple and narrow and without centripetal diverticulæ. There are four straight narrow radial canals; upon the mid regions of which are the papilliform gonads (see Fig. 45). The manubrium is flask-shaped and there are four simple cruciform lips (see Fig. 46). The entoderm of the manubrium, gonads, and circular canal is dull rosin yellow. There are four green entodermal pigment spots upon the manubrium near the points of junction of the four radial canals. The internal endoderm of the bases of the adhesive tentacles is rich magenta-purple, while an intense green color extends a short distance outward into the endodermal shaft of the tentacle. The bases of the non-adhesive tentacles are dull green without the magenta color.

This medusa is very active, swimming rapidly with a few powerful pulsations, and then slowly sinking down with tentacles outspread. It often attaches itself to objects by means of its adhesive disks.

Development of the Medusa: In a specimen 1 mm. in diameter (Fig. 43), the bell was higher than a hemisphere and the exumbrella surface regularly sprinkled with nematocysts. There were sixteen tentacles. The radial and interradial tentacles had as yet no adhesive disks but terminated in simple nematocyst knobs. The eight intermediate tentacles, however, had such disks, a condition exactly the reverse of which was observed in a young C. geophila from Key West (see Bull. Mus. Comp. Zoöl. Harvard College, Vol. XXXVII, No. 2, Pl. 5, Fig. 10). There were only four otocysts at this stage, and the manubrium was rudimentary.

When 6 mm. in diameter (Fig. 44) the bell is hemispherical. There are about twenty sucker-bearing tentacles alternating with an equal number of

nematocyst-bearing ones. There are twelve otocysts, and the manubrium is flask-shaped. The gonads, which begin to develop upon the radial canals at the four corners of the manubrium, have now migrated down the radial canals, although they are still small and immature.

Cubaia geophila, of Key West, is closely allied to C. aphrodite and may be simply a variety of the latter. In C. geophila, however, we find none of the magenta-purple pigment at the bases of the tentacles. The bell is flatter, and the manubrium longer and more slender, and the edges of the radial canals, over the gonads, display dark colored, scattered pigment granules.

In C. aphrodite the gonads are developed upon the middle portions of the radial canals, while in C. geophila they are found upon the outer (centrifugal) halves of the canals.

Olindias tenuis.

Figs. 50-52, Plate V; Figs. 53-59, Plate VI.

Mature Medusa: Figs. 53, 54, 58, 59; Plate VI. Bell hemispherical, 35 mm. in diameter. Gelatinous substance quite rigid.

There are about ninety tentacles. Thirty-two of these are straight, about one-third as long as the bell-diameter, and arise from the sides of the bell in a zone at a short distance above the margin. These tentacles are besprinkled with wart-like clusters of nematocysts, and near their distal ends on the aboral side one finds an elongate, pad-like cluster of nematocyst cells, having a sucker-like appearance, although there is no evidence that it actually functions as an organ of adhesion. (Fig. 57, Plate VI.)

In addition to the short, straight tentacles there are about sixty others which are very flexible, and are often seen coiled in close helices. When extended these tentacles are about four times as long as the bell-diameter. They arise from the bell-margin below the zone of origin of the straight tentacles. A powerful strand of longitudinal muscle fibres extends throughout the entire length of the outer side of each of these velar tentacles, while half rings of nematocysts are found at regular intervals upon their inner sides.* (See Figs. 54, 58). The tentacles are thus comparable in their structure to the long ones of Physalia. They terminate in a knob-like cluster of nematocysts, and upon their aboral sides near the distal end there is a flat pad-like cluster composed of very elongate and thickly crowded ectodermal cells. (Fig. 58a.)

* According to Goto, 1903, similar rings are found on the *outer* sides of the velar tentacles in Olindioides.

In addition to the tentacles there are about sixty-four bluntly rounded papillæ upon the bell-margin.

There are sixty-four otocysts, a pair on either side of the origin of each and every one of the short, straight tentacles. Each otocyst contains a single spherical otolith.

There are four straight narrow radial canals and twenty-eight diverticulæ, which extend inward from the circular vessel, and end blindly in the gelatinous substance of the bell. The otocysts flank the sides of these radial canals and diverticulæ (see Fig. 53).

The four gonads are papilliform and are developed upon the outer halves of the four radial canals (see Fig. 59)

The manubrium is tubular, cruciform in cross section and elongate, and has four recurved lips. It extends about three-quarters of the distance from the inner centre of the bell cavity to the velar opening.

The gelatinous substance of the bell is of a delicate greenish yellow. The entoderm of the manubrium gonads and tentacle bulbs is opaque yellow-green, with the innermost parts purple. There are four interradial, reddish purple, pigment spots upon the manubrium near the points of origin of the radial canals. The nematocyst-warts upon the short tentacles are either white or dark purple, while the half-rings on the long, flexible tentacles are red and yellow.

Development of Medusa: The youngest medusæ (Fig. 50, Plate V) observed were about 0.7 mm. in diameter, the bell being higher than a hemisphere and the exumbrella surface regularly besprinkled with nematocysts. There were eight tentacles, four radial and four interradial. These all belonged to the short, straight, "adhesive" set and projected from the sides of the bell above the bell-margin. There were only four otocysts, one at the base of each interradial tentacle. The radial canals were narrow and straight-edged, and the circular vessel was simple without centripetal diverticulæ. The manubrium was quadratic, and very short.

As the medusa grows its bell increases in height relatively faster than in width, so that it becomes higher than a hemisphere and resembles in shape the bell of Bougainvillia. When 3 mm. high (Fig. 51, Plate V) there are still only eight tentacles, but the radial canals have become broad with serrate edges, and four interradial diverticulæ begin to develop from the circular vessel. The eight tentacles have greatly elongated and terminate in simple nematocyst-

knobs (see Fig. 55, Plate VI). When the medusa is 8 mm. in diameter (Fig. 52, Plate V), there are sixteen of the tentacles that project from the sides of the bell, and about an equal number of the flexible, coiled tentacles that arise from the bell margin. There are thirty-two otocysts, a pair flanking each of the sixteen tentacles that arise from the sides of the bell, and twelve centripetal diverticulæ from the circular vessel that extend into the gelatinous substance of the bell. The gonads have not yet made their appearance. The tentacles that arise from the sides of the bell have begun to develop their peculiar pad-like disks upon their aboral sides (see Fig. 56, Plate VI). These pad-like disks, which are evidently homologous with the adhesive disks in Gonionemus and Cubaia, are developed from the aboral side of the primitive nematocyst knob of the tentacle, as is shown in successive stages represented in Figs. 55, 56, 57, Plate VI. We see, then, that the youngest medusa of Olindias may be said to be in the "Gonionemus stage," for it has only tentacles of the "sucker-bearing" set, and the circular canal is simple without diverticulæ. It seems probable therefore that Olindias is descended from a Gonionemus-like medusa.

Olindias tenuis is one of the few medusæ that thrive best on the shallow flats of the Bahamas and Florida coast, and is very abundant during the summer months in Nassau Harbor, and at Key West, Florida.

Liriope scutigera, McCrady.

Fig. 31, Plate IV.

Brooks, W. K., 1886; Mem. Bost. Soc. Nat. Hist., Vol. III, p. 373, Pl. 41, 42.
McCrady, J., 1857; Gymn. Charleston Harbor, p. 106.
Xanthea scutigera, Haeckel, E., 1864; Geryoniden, p. 24.
Liriantha scutigera, Haeckel, E., 1879; Syst. der Medusen, p. 287.

Adult Medusa: Bell bluntly conical, flatter than a hemisphere, and about 8 mm. in diameter. Four long, hollow, radially situated tentacles. In young specimens there are four short, stiff, solid, radial tentacles that project from the sides of the bell, but these are cast off or absorbed before the medusa is mature, and are replaced by the hollow, permanent tentacles. There are eight otocysts, each having a single spherical otolith. The otocysts project inward into the bell cavity above the velum and are radial and interradial in position. The velum is well developed. There are four slender radial canals and a simple narrow circular vessel without centripetal diverticulæ. The manubrium is at the extremity of a long tapering peduncle which projects beyond the velar opening. The four cruciform lips are curtain-like and folded and

there is a well developed "tongue." The four heart-shaped gonads are found upon the radial canals immediately above the circular vessel. The entoderm of the manubrium is green. Common in the West Indies and Florida region and occasionally drifted upon the New England coast in summer.

Glossocodon tenuirostris, Fewkes.

Fig. 33, Plate IV.

Fewkes, J. W., 1882; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. IX., p. 278, Pl. VII., Figs. 1-9.

Liriope cerasiformis, Maas, O., 1893; Ergeb. der Plankton Exped., Bd. II., K. C., p. 35, Taf. II., Figs. 5, 6.

Liriope tenuirostris, Agassiz, L., 1862; Cont. Nat. Hist. U. S., Vol. IV., p. 365.

Bell bluntly conical, 7 mm. wide. Four long, hollow, tapering, radial tentacles ringed at regular intervals. Four short-stiff, interradial, club-shaped tentacles which project upward from the bell-margin. Eight otocysts on inner side of bell cavity, one at base of each tentacle. Velum well developed. Manubrium slender, about as long as the width of the bell. Peduncle short and conical. Four lips, simple, cruciform, and studded with nematocysts. Four broad radial canals. Circular vessel broad with four blindly ending centripetal diverticulæ. Four gonads at the middle of each of the four radial canals. Entoderm of manubrium green, lips and long hollow tentacles pink.

Abundant in Bahamas, West Indies, and Tortugas. Occasionally drifted northward to the southern coast of New England.

Aglaura hemistoma, Péron and Lesueur.

Fig. 34, Plate IV.

Péron, F. et Lesueur, C. A., 1809; Tableau des Meduses, p. 351, No. 73.

Bell cylindrical 4 mm. high, with vertical sides and flat top. Bell-walls very thin but quite rigid. Tentacles numerous but very brittle, so that they are usually found to be broken off short. Eight small marginal otocysts. Velum well developed. Eight slender, straight, radial canals. Manubrium flask-shaped with four curved lips. A cylindrical peduncle above the manubrium. Eight sausage-shaped gonads arise from the proximal part of the gastric portion of the manubrium. The entoderm of the manubrium is rosin-brown. Common in West Indian region and Tropical Atlantic.

Aegina rhodina, Haeckel.

Figs. 28, 28a, 29, Plate IV.

Haeckel, E. 1879 ; Das Syst. der Medusen, p. 338, Taf. XX., Figs. 11-15.

Bell of mature medusa 40-50 mm. wide. Of the specimen figured by us, 7 mm. Sides of bell sloping; apex rounded. There are four tentacles each about as long as the bell-diameter, their entodermal cells are disk-like, and a single row of nematocysts extends down their outer sides (see Fig. 29). These tentacles arise from the sides of the bell half-way between the margin and apex. There are twelve sense organs upon the bell-margin, each containing two crystalline otoliths (Fig. 28a). The velum is well developed. The gastric portion of the manubrium surrounds a conical mass of gelatinous substance which projects from the inner apex of the bell cavity and occupies the centre of the stomach. The mouth is a simple round opening. There are eight genital pouches, two in each quadrant. Their outer edges are quadratic, and they are separated by a very small space. The genital organs and tentacles are delicate pink, while the gastric part of the manubrium is intense green. A single immature specimen was found at Mastic Point, Andros Island, Bahamas, in a surface tow on June 20, 1903. Haeckel found three specimens in the Canary Islands in January, 1867.

Haeckel's description accords with ours, excepting that he finds sixteen instead of twelve marginal sense organs; and he states that the stomach is pale-reddish instead of intense green as observed by us.

Cunoctantha, sp.

Figs. 36-42, Plate IV.

A budding nurse, or stolon, of Cunoctantha was found floating freely in the water at the Tortugas, Florida, in July. Only one end of this stolon was perfect, the other extremity being in a state of advanced disintegration so that its form was indeterminate. It was, therefore, somewhat remarkable that the budding end of the stolon was apparently in a perfect healthy condition and survived for a whole day in the aquarium, giving rise to medusæ in considerable numbers. It is possible that the disintegrated end of the stolon was being absorbed to provide nutriment for the budding end, but this is a mere conjecture.

Figs. 37-41 represent successive stages in the formation of the medusa-buds. The bud is at first pyriform, and then its base becomes surrounded by a collar destined to form the medusa-bell. The eight tentacles and eight

otocysts develop simultaneously. When set free the medusa has eight well developed tentacles, and eight marginal sense organs; each containing two spherical otoliths (Figs. 41, 42).

SCYPHOMEDUSAE.

Tamoya haplonema, F. Müller.

Figs. 61-64, Plate VII. (Fig. 60?.)

Müller, F., 1859; Abhandl. Naturf. ges. Halle, Bd.V., p. 1, Taf. I., II.
Agassiz, L., 1862; Cont. Nat. Hist. U. S., Vol. IV., p. 174.
Haeckel, E., 1880; Syst. der Medusen, p. 443.
Young medusa? "Tamoya punctata," Fewkes, J. W., 1883; Bull. Mus. Comp. Zoöl. at Harvard Coll., Vol. XI., No. 3, p. 84, Pl. I., Figs. 4-6.

The young of the Charybeidæ are so different in appearance from their adults, and the characteristic structures, observation of which is necessary for their classification, are so late in developing that it is all but hopeless to attempt to determine them. For example: the young specimens called "Tamoya punctata" Fewkes (Fig. 60, Plate VII) are exceedingly abundant in the Bahamas during the spring and summer, whereas the adult is unknown. When young they swim near to the surface while it seems probable that the adults sink to the bottom.

However, the young "Tamoya punctata" lacks all trace of gastric cirri, gonads, velar canals, or well developed pedalia; and we are therefore unable to state whether it be the young of Tamoya or Charybdea. Moreover, the exumbrella of the young Charybeidæ are usually besprinkled with prominent, more or less pigmented, clusters of nematocysts which are often arranged in definite rows. These either lose their regular order or become much less prominent in the adult, so that while they are a most conspicuous feature of the young they are quite inconspicuous in the mature animal. We see, therefore, that the names of immature forms, such as "Tamoya punctata," Fewkes; "Charybdea aurifera," Mayer; and "Charybdea verrucosa," Hargitt, have practically no significance.

It seems possible, however, that "Tamoya punctata," Fewkes, is the young of Tamoya haplonema, F. Müller.

Tamoya haplonema is widely distributed, having been found on the coast of Brazil; in the West Indies; at Beaufort, North Carolina; and in Great Peconic Bay, Long Island, New York. Our Figures, 61-64, were obtained from a specimen captured at the last named place early in September, 1902.

A number of specimens of this medusa, in various stages of growth, were obtained at this time. They were all captured in a dredge at a depth of two fathoms, about one quarter of a mile off Brown's Point, Great Peconic Bay, where the bottom was covered with drifting sea-weed. None were seen upon the surface.

Adult Medusa, Tamoya Haplonema.

Figs. 61–64, Plate VII.

Bell 90 mm. high, 55 mm. wide; with vertical sides and relatively flat top. Exumbrella surface thickly covered with white wart-like clusters of nematocysts. Four pedalia, 30 mm. long, wing-like and sharp-edged. Tentacles 90 mm. long, hollow, very flexible, and bearing regularly spaced rings of nematocysts that are capable of inflicting a severe sting to the hand. The sensory clubs (Figs. 63, 64) have two large median, and four small lateral eyes, all being upon the inner side of the bulb. The large eyes are provided with prominent convex lenses and are ectodermal. There is a large terminal entodermal otolith composed of a mass of concretions.

The velarium is well developed, and there are ten dendritic velar canals in each quadrant which terminate in numerous, non-anastomosing branches (see Fig. 62).

The nervous ring running from the base of each pedalium to the sensory clubs is distinctly visible as a white colored cord.

The stomach extends about one-third of the distance from the inner apex to the level of the valarium, and there are four slightly recurved lips. The gastric cirri are short and numerous.

The genital organs are curtain-like with frilled edges. They project from the interradial septæ into the gastro-vascular pouches of the bell on either side. There are thus eight curtain-like sheets projecting into the four radial pouches. In old specimens the gonads are so large that their free edges overlap beyond the central line of each pouch.

The gelatinous substance of the bell is transparent. The long, flexible tentacles are a milky yellow, often with a faint purple-hue. There are large white wart-like clusters of nematocysts over the pedalia and valarium. The genital organs are milky-yellow, and the eyes dark brown.

This medusa is exceedingly active, and the gelatinous substance of its bell tough and rigid.

Nausithoë-punctata, Kölliker.

Kölliker A., 1853; Zeit. für Wissen. Zoöl. Bd. IV, p 323.

Nausithoë albida, Carus, V., 1857; Icones Zootom. Taf. II, Fig. 17, 22, 23, var. pacifica Agassiz, A. and Mayer, A. G., 1902; Mem. Mus. Comp. Zoöl., Vol. XXVI, p. 155 Pl. 7, Fig. 32.

This medusa is abundant in the Bahamas, Tortugas and Mediterranean during the summer months, and a closely allied variety is found in the Tropical Pacific.

Linerges mercurius, Haeckel.

Haeckel, E., 1880; Syst. der Medusen, p. 495, Taf. XXIX, Fig. 4-6.

The young ephyræ of this medusa appear in vast numbers in the Bahamas in March and grow rapidly to maturity, disappearing before the first of June. A closely allied species, Linerges aquila, is common in November and December in many of the lagoons of Atolls in the Tropical Pacific.

Aurelia habanensis, Mayer.

Mayer, A. G., 1900, Bull. Mus. Comp. Zoöl at Harvard Coll., Vol. XXXVII, p. 69, Figs. 73, 74, Pl. 24; Fig. 86, Pl. 26.

The ephyræ of this species appear in considerable numbers in June and July, and mature individuals are abundant in August. Mature specimens are also found in Havana harbor in February.

Cassiopea frondosa, Lamarck.

Lamarck, J. de., 1817; Hist. anim. sans vert., Tom. II, p. 512.

Medusa frondosa, Pallas, P. S., 1774; Spicilegia Zoöl. Fasc. X, p. 29, 30; Pl. 2, Fig. 1-3.

Cassiopea frondosa, Tilesius, W. G., 1834; Beitrage zur Nat. der Medusen, Acad. Cæs. Leop. Nova Acta, Tom. XV, p. 263, 278; Tab. LXXII, Figs. 1-5.

Polyclonia frondosa, Agassiz, L., 1860; Cont. Nat. Hist. U. S., Vol. III, Pls. 13, 13a.

This medusa is locally abundant in spring and summer. It prefers muddy bottoms where the water is not very pure and often remains motionless for long periods of time with its disk pressed against the ground, its oral side and mouth arms being uppermost.

It is abundant in June and July in the moat of Fort Jefferson, Dry Tortugas, Florida.

Siphonophoræ.

The Siphonophoræ of the Bahamas are species common also to the Tropical Atlantic. They are more abundant at the surface in winter than in summer, when they probably sink to a considerable depth.

Ctenophoræ.

Bolina vitria is abundant over the shallow banks in summer, while Beroë Clarkii is found commonly in the spring.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Lymnorea Alexandri,* nov. sp., Half-grown medusa.
" 2. " " Full-grown medusa.
" 3. " " Side view of tentacle showing ectodermal ocellus.
" 4. " " Side view of manubrium showing nematocyst knobs.
" 5. " " Enlarged view of a nematocyst knob of manubrium.
" 5a. " " Section of swollen portion of radial canal showing vacuolated entodermal cells.
" 6. *Syndictyon angulatum,* Mature medusa.
" 7. *Netocertoides brachiatum.* Mature medusa.
" 8. *Halitiara formosa.*
" 9. *Stomotoca australis.*

PLATE II.

Fig. 10. *Dissonema turrida.* Mature medusa.
" 11. *Tiara superba.* Mature medusa.
" 12. *Willia ornata.* Mature medusa.
" 13. *Hybocodon Forbesii.*
" 14. *Bougainvillia niobe.* Mature medusa.
" 15. " " Section of the manubrium showing medusa buds, in various stages, developing within the ectoderm (*ect*). The entoderm, and the limiting membrane (*s l*) remaining unbroken and inert
" 15a. " " Very young bud (*ent. b*), entoderm of the bud. (*c*) Mass of cells within the central cavity of the entoderm. These probably contribute to the nutrition of the bud.
" 15b, 15c. " " Successive stages in the development of the medusa buds. Lettering as in previous figures.

PLATE III.

Fig. 16. *Epenthesis folleata.* 16a. Side view of manubrium.
" 17. *Eucheilota paradoxica.* Young medusa.
" 18. " " Medusa-bud about to be set free.
" 19. *Obelia* sp.
" 20. " *tentacle and otocyst.*
" 21. *Tiaropsis punctata.*
" 22. *Parvanemus degeneratus, gen. et sp. nov.*
" 23. *Oceania McCradyi.* Mature medusa.
" 24. " A medusa-bud from one of the hydroid blastostyles.
" 25. *Phortis pyramidalis.*
" 26. *Zygodactyla cyanea.*
" 27. " " Portion of bell margin.

PLATE IV.

Fig. 28. *Aegina rhodina,* 28a. Otocyst.
" 29. " " Tentacle.
" 30. *Laodicea ulothrix.*
" 31. *Liriope scutigera.* Mature medusa.
" 32. *Tetracannota collapsa.* Young medusa.
" 33. *Glossocodon tenuirostris.* Mature medusa.
" 34. *Aglaura hemistoma.*
" 35. *Cladonema Perkinsii.* Copied by permission from a drawing by Professor H. F. Perkins, in Johns Hopkins University Circulars, Vol. XXI, No. 155.
" 36. *Budding stolon of Cunoctantha.*
" 37-41. *Successive stages in the development of medusa-buds on the stolon of Cunoctantha shown in Fig. 36.*
" 42. *Marginal sense organ of the medusa of Cunoctantha when about to be set free.*

PLATE V.

Fig. 43. *Cubaia aphrodite.* Young medusa.
" 44. " " Half-grown medusa.
" 45. " " Full-grown medusa.
" 46. " " Manubrium of Fig. 45.
" 47. " " Otocyst.
" 48. " " One of the velar tentacles.
" 49. " " One of the sucker-bearing tentacles.
" 50. *Olindias tenuis.* Young medusa.
" 51. " " Older than Fig. 50.
" 52. " " Half-grown medusa.

PLATE VI.

Fig. 53. *Olindias tenuis.* Mature medusa.

" 54. " " Side view of bell-margin, showing that the short tentacles arise from the sides of the bell above the margin, while the long flexible tentacles arise from the bell-margin. The short tentacles have each a sucker-like, nematocyst-pad upon the aboral side of their distal ends; while the long flexible tentacles have numerous half-rings on their inner, and a well developed strand of longitudinal muscle fibres upon their outer sides.

" 55-57. " " Successive stages in the development of the sucker-like nematocyst-pad upon the aboral side of the short tentacles in medusæ the diameter of whose bells are respectively 2 mm., 8 mm. and 16 mm.

" 58. " " Side view of a portion of one of the long tentacles showing the half-rings of nematocysts on the inner and the strand of longitudinal muscle fibres on the outer side.

" 58a. " " Extremity of one of the long flexible tentacles showing the terminal knob of nematocysts, and the pad-like thickening upon the outer side of the tentacle, composed of closely crowded elongate nematocyst cells.

" 59. " " View of one of the gonads.

PLATE VII.

Fig. 60. *"Tamoya punctata,"* Fewkes.

" 61. *Tamoya haplonema,* F. Müller. Side view, natural size. Specimen from Great Peconic Bay, Long Island, New York.

" 62. " " View of canals in the velarium.

" 63. " " The sensory club seen from the centripetal side.

" 64. " " The sensory club seen from the side, showing ectodermal eyes, and entodermal otolith.

" 65. *Section through the gonad of Eucheilota paradoxica.* Showing that the entoderm and ectoderm of the bud are derived directly from the same layers of the gonad. *ect,* ectoderm; *ent,* entoderm. *b,* gonad of the budding medusa.

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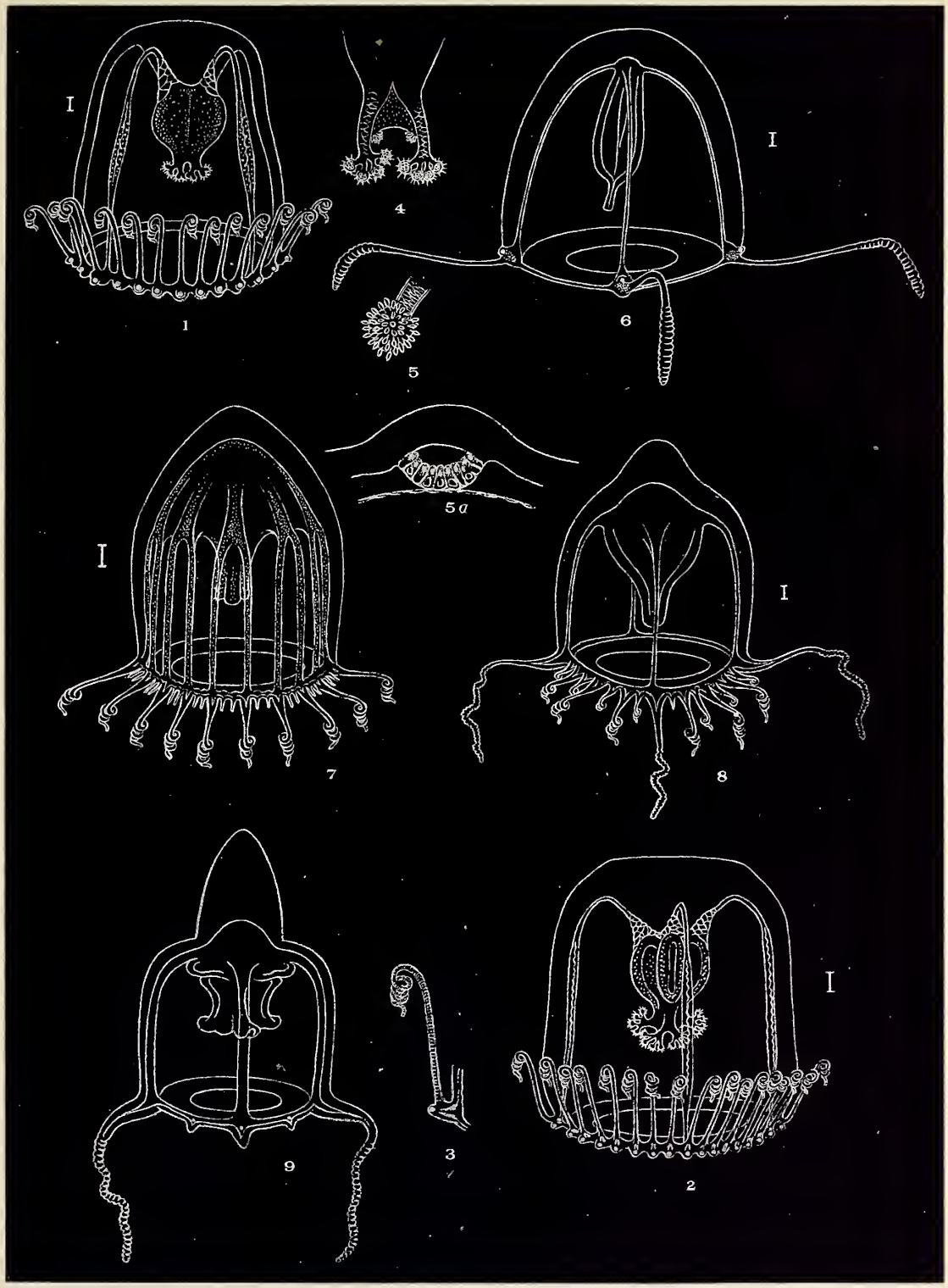

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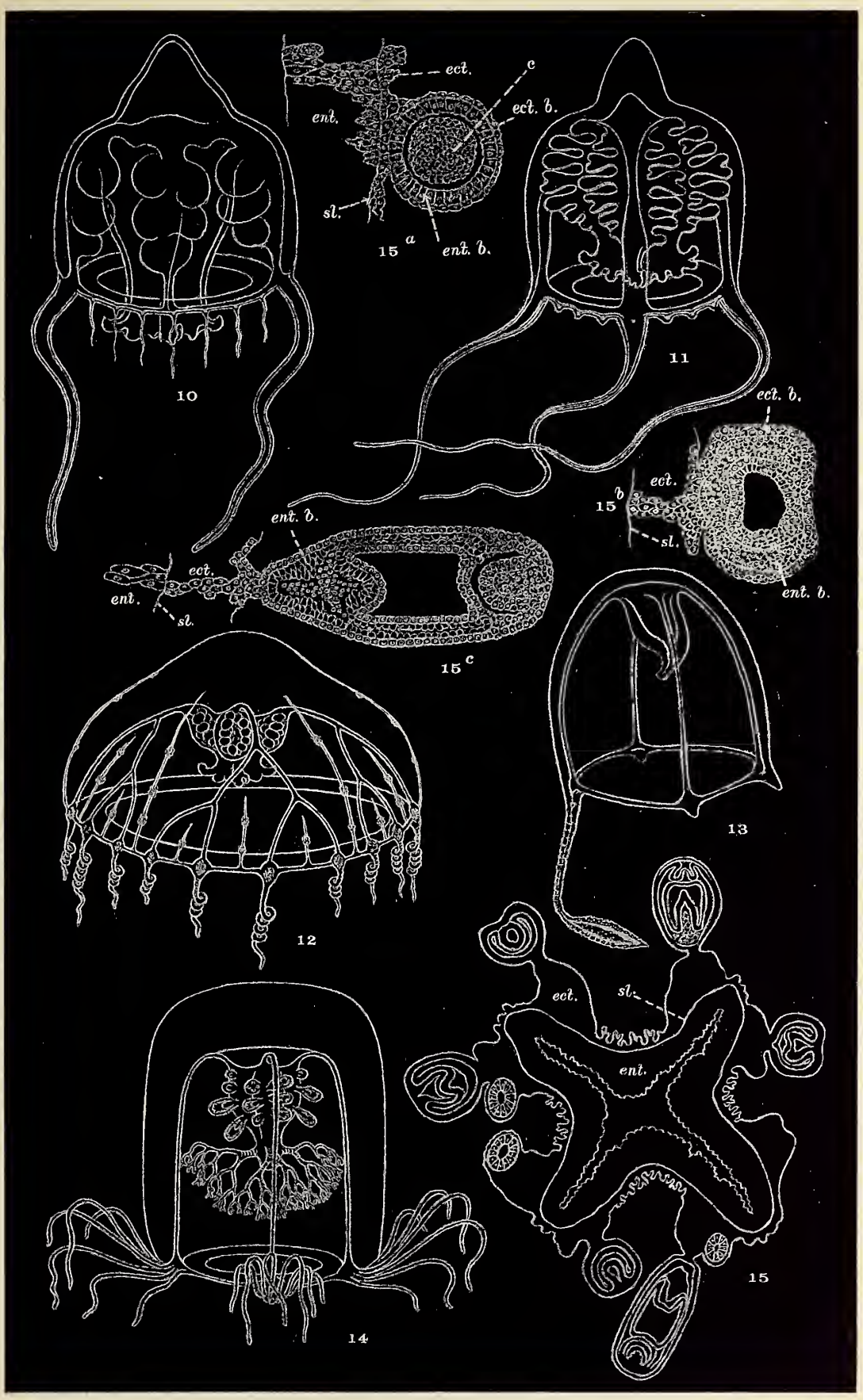

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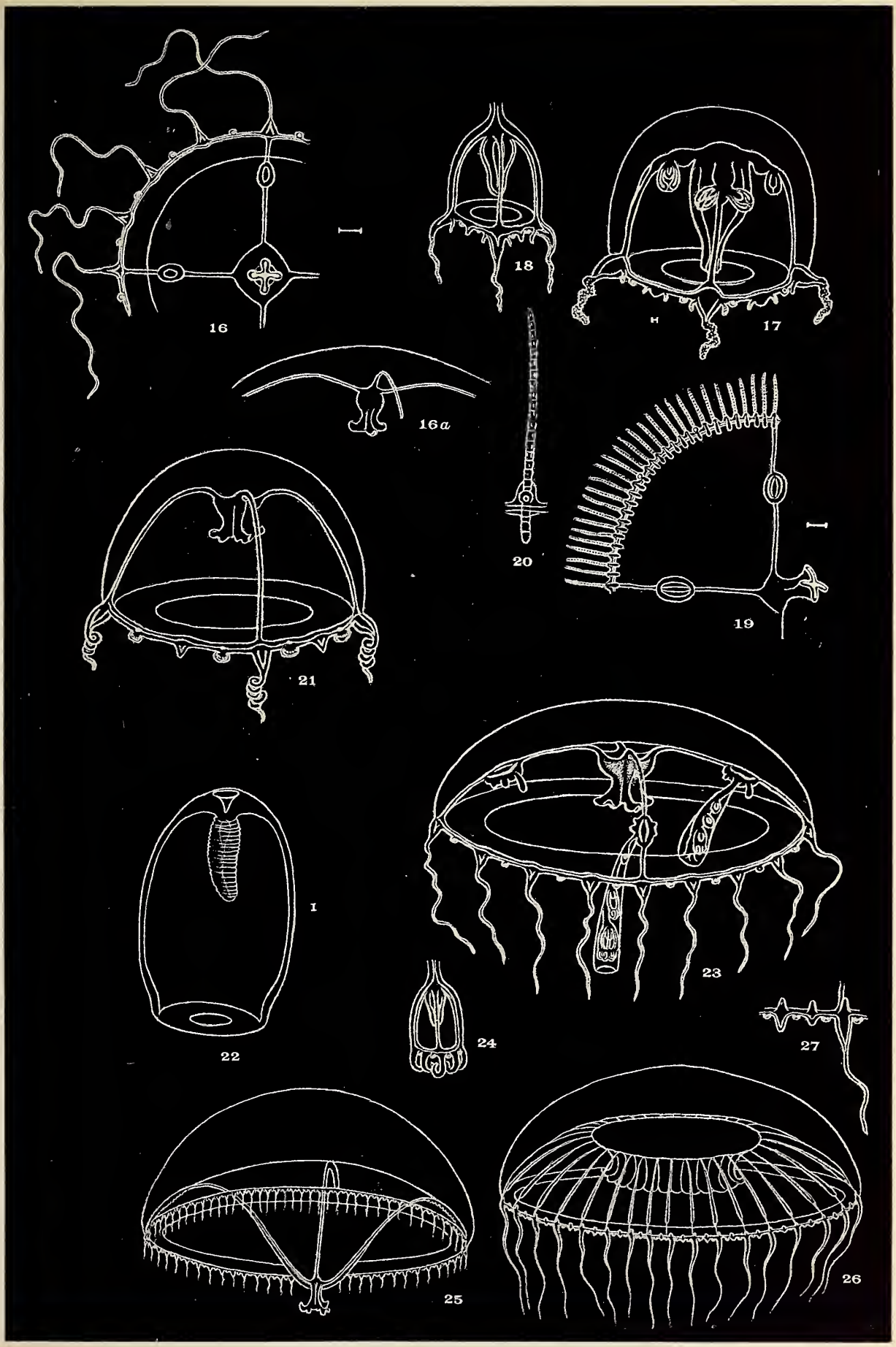

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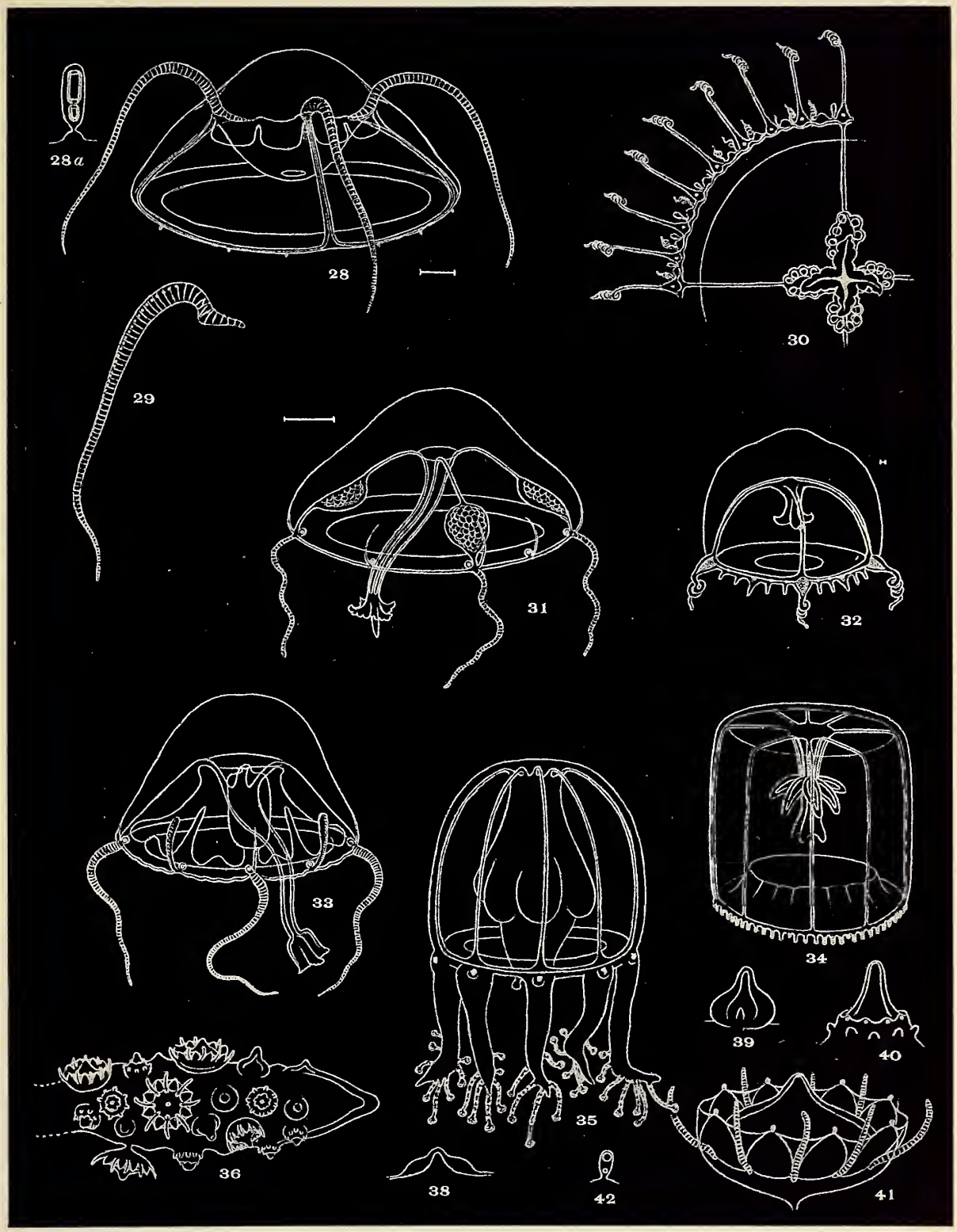

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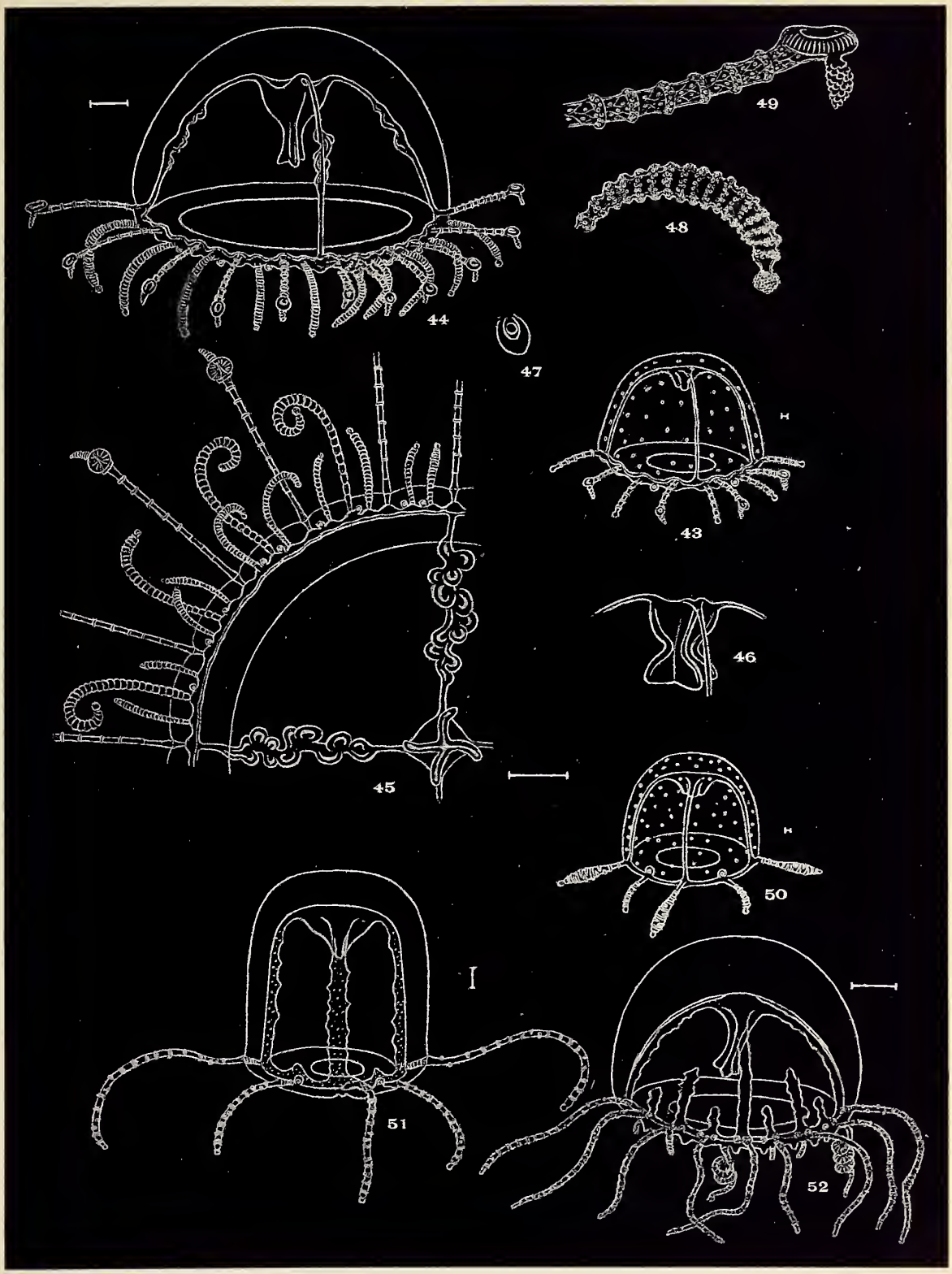

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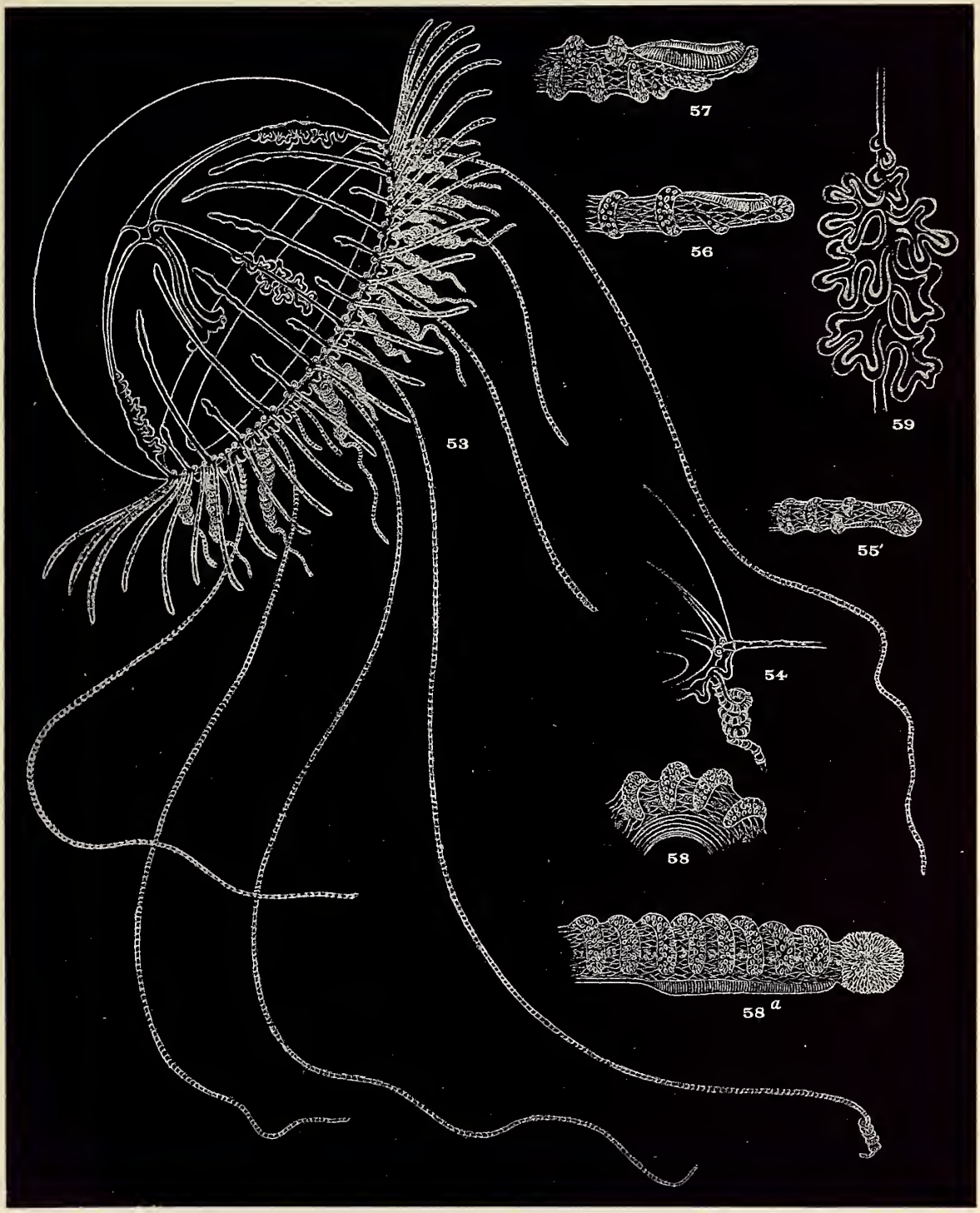

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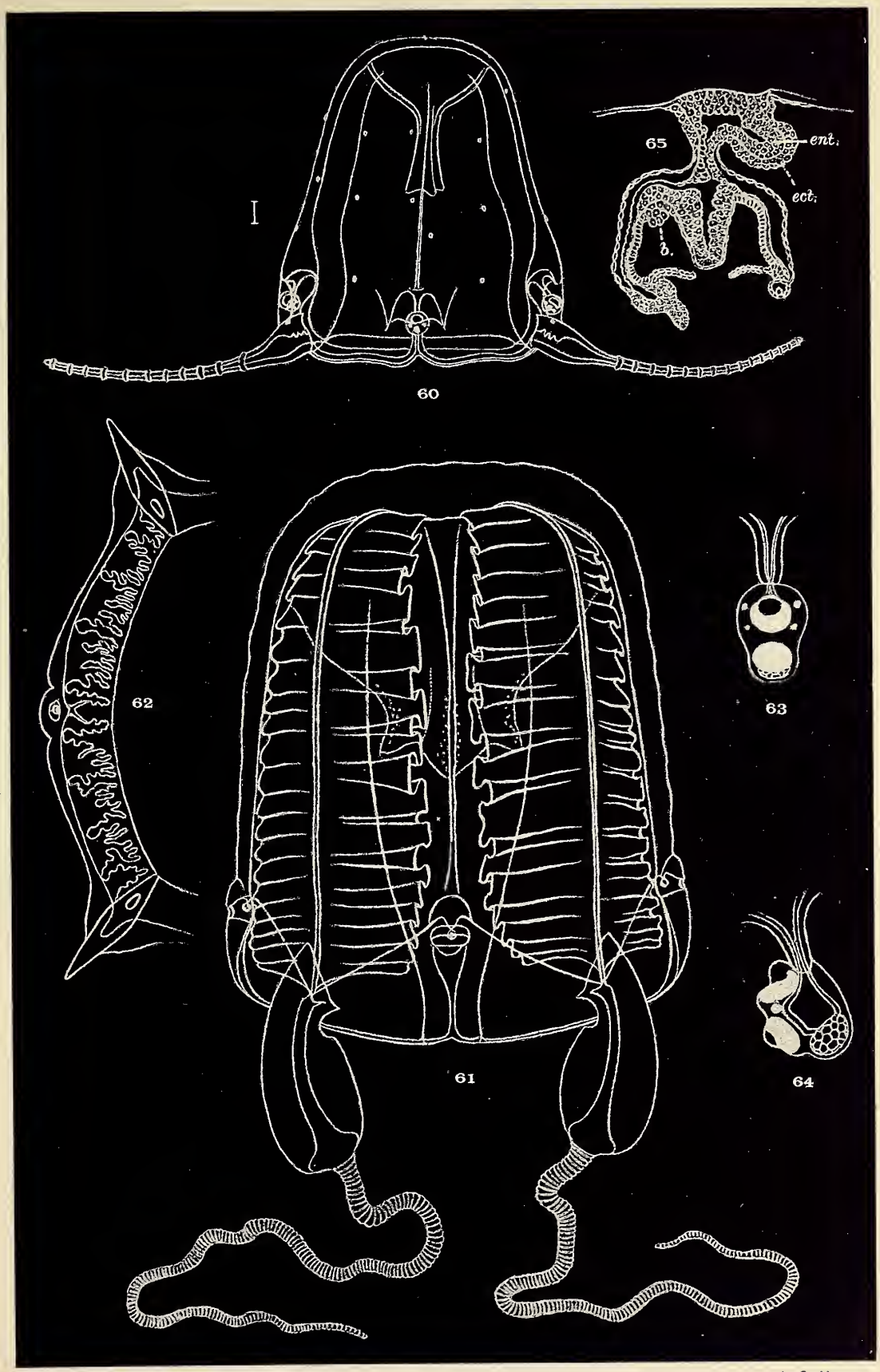

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